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Research Report 1384

Development and Evaluation of Sustainment Training Materials for M60A3 Armor Crewmen

Ronald E. Kraemer

ARI Field Unit at Fort Knox, Kentucky
Training Research Laboratory



U. S. Army

Research Institute for the Behavioral and Social Sciences

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retention, and skills transfer to novel situations. Front end analysis clearly indicates that the training materials are viable for individual skills sustainment and cross training purposes. The actual training effectiveness of the materials for use by armor crewmen remains undetermined.

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FOREWORD

The Small Unit Training Team of the Army Research Institute for the Behavioral and Social Sciences (ARI), Fort Knox Field Unit performs research and development efforts designed to improve the combat effectiveness of small units by exploring technologically up-to-date methods for training soldiers to acquire and sustain military skills and knowledges. Of particular research interest are methods for task prioritization, training program structuring and management, field-proven methods for in-unit mobilization train-up and cross-training, and methods for implementing training materials on micro- and hand-held computers.

This report describes research efforts to develop and evaluate training materials that M60A3 armor crew members can use to supplement, enrich, and thereby sustain proficiency in three critical job performance areas: fire commands, degraded mode gunnery, and multiple returns.

Further development of these concepts and training materials will lead to methods and materials for hand-held computer training.


EDGAR M. JOHNSON
Technical Director

DEVELOPMENT AND EVALUATION OF SUSTAINMENT TRAINING MATERIALS
FOR M60A3 ARMOR CREWMEN

EXECUTIVE SUMMARY

Requirement:

To improve the combat effectiveness of small units by exploring technologically up-to-date methods for training soldiers to acquire and sustain military skills and knowledges.

Procedure:

A two-phase research study that included a development phase and an evaluation phase was conducted to provide armor units with training materials that individual soldiers could use to supplement, enrich, and thereby sustain recently acquired skills and knowledges. In the development phase, critical job performances were identified for training material development. Self-contained Study Guides were subsequently prepared to convey the knowledges and permit soldiers to apply those knowledges in a job-like setting. The evaluation phase of the research was designed to (a) determine the amount of learning achievement gain made by soldiers who use the training materials and (b) assess the utility and user acceptance of the materials in sustaining previously acquired skills and knowledges.

Findings:

Development of the sustainment training materials for M60A3 armor crewmen was largely successful. Self-contained study booklets were developed to sustain individual proficiency in fire commands, degraded mode gunnery, and multiple returns; three job performance areas considered critical to combat success. For skills and knowledge acquisition, a training methodology was followed that combined the qualities of incremental learning, self-paced instructions, and the benefits of immediate feedback through knowledge of results. Realistic job-like problem scenario booklets were constructed for skill development. These situational problems permitted soldiers to apply their acquired skills and knowledges within the functional context of armor combat. User acceptance of the training materials for sustainment and cross-training purposes was overwhelmingly favorable. Empirical data to support the training effectiveness of the materials, however, was not obtained. Most soldiers failed to use the self-instructional training materials as intended because of higher unit priorities, low motivation, or lack of available study time.

Utilization of Findings:

This paper presents the results of a sustainment training material development and evaluation research study. Controlled use of the training materials, combined with adequate command emphasis and quality control measures, may allow active Army and Reserve Component M60A3 Armor units to meet the individual skills sustainment and cross-training needs of its personnel.

DEVELOPMENT AND EVALUATION OF SUSTAINMENT TRAINING MATERIALS FOR M90A3 ARMOR CREWMEN

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DEVELOPMENT AND EVALUATION OF SUSTAINMENT TRAINING MATERIALS
FOR M60A3 ARMOR CREWMEN

INTRODUCTION

Background

Armor units in the Active Army and Reserve Component are rapidly transitioning to more technologically advanced tank weapon systems. During the FY 80-83 time frame, Active Army armor battalions in both the Continental United States (CONUS) and Europe (USAREUR) received M60A3 tanks equipped with laser rangefinders and thermal optics to replace older M60 series tanks. Recently, new and improved M1 Abrams tanks with vastly improved fire control system, power plant, suspension, and armor protection were delivered to armor units in CONUS and USAREUR.

During the FY 78-80 time frame, armor battalions in the Army Reserve Components received M48A5 tanks to replace the outdated M48A1 tank. In FY 82, the Army stepped-up its efforts to improve the equipment stocks of high priority Reserve Component units on the same schedule as Active Army units. New M60A3 tanks with improved night fighting capabilities were delivered to the National Guard. In FY 83, M1 Abrams tanks were delivered to the National Guard. During the FY 84-86 time frame, additional Army National Guard tank battalions are scheduled to receive the M1 Abrams tanks.

Training for the initial fielding of both M60A3 and M1 Abrams tanks is provided by New Equipment Training (NET) teams. These teams normally consist of one armor officer and several senior noncommissioned officers (NCO) qualified in the Military Occupational Specialty (MOS) job for which NET is being provided. NET teams, under the direction and assistance of the Training and Doctrine command (TRADOC), develop the program of instruction (POI) for training delivery.¹ Available training resources such as operator manuals issued with the tank, subcaliber gunnery training devices, graphic training aids, etc., are integrated to support the training subsystem. The length of time dedicated for NET can vary from two to six weeks depending on army regulations and the entry-level skills of the soldiers being trained. The NET, for National Guard units, for example, is limited to a maximum of two weeks. NET is seat-specific. That is, tank commanders are only trained on tank commander tasks, gunners in gunner tasks, etc. There is no attempt during NET to be all inclusive. Tasks not trained become the responsibility of the unit. The traditional end of training measure of performance success for both NET trained soldiers and cadre is Table VIII; the test of crew performance in engaging targets using the tank-mounted weapons.

The training of newly enlisted soldiers on new armor weapon systems is provided during advanced individual training/basic armor training (AIT/BAT) by the US Army Armor Center (USAARMC), Fort Knox, Kentucky. Its training

¹U.S. Army Regulation. Development of basic information for individual and unit training. AR 71-5, November 1981.

goals are quite similar to those of NET which are to familiarize the individual soldier with a specific weapon system so that he can safely and effectively operate and maintain it with minimal assistance. During the last six weeks of AIT/BAT, soldiers are trained in three tank crew duty positions: gunner, loader, and driver. Upon graduation, they are qualified and licensed as either M60A3 or M1 Abrams drivers. Additional skills training in more intermediate and advanced driving, as well as the requirements for loader and gunner positions, is left up to the receiving unit.

The Army training and evaluation program (ARTEP) is the principal training document for Army units. It is based on a decentralized philosophy of training which encourages the simultaneous training of several echelons of a unit or a multi-echelon training approach to individual and collective task requirements. It is also based on a performance-oriented training model that emphasizes the preparation for job performance through the explicit statement and mastery of training objectives. The ARTEP is the "encyclopedia" of unit missions, or collective training tasks, that the unit must be capable of performing to be combat ready.

The ARTEP prepared and published by the USAARMC for Armor units is ARTEP 71-2, Mechanized Infantry/Tank Task Force. Training support is provided by the ARTEP Mission Training Plans (AMTP): FM 17-15-1 (Draft) Div 86 Tank Plt AMTP; FM 17-16-1 (Draft) Div 86 Hvy CO/TM AMTP; and FM 17-17-1 (Draft) Div 86 Tank Bn/Task Force AMTP. These products present descriptive training exercises based on eight selected ARTEP missions critical to all units. The recent training text, TT 71-1/2, the Abrams Battalion, provides interim doctrine for integrating the M1 into the combined arms team and for exploiting its improved capabilities. It also applies to M48A5 and M60A3 units that have converted to the Division 86 organization. Together, these documents contain situational training exercises (STX), field training exercises (FTX), and live-fire exercises (LFX) designed to train and evaluate all elements of a combined arms unit to perform specified missions under simulated combat conditions.

To assist units prepare individual soldiers, crews, tanks with wingman, and platoons for combined arms tactical training at higher unit levels, USAARMC provides the Tank Combat Tables: FM 17-12-1 for M1 Abrams units and FM 17-12-3 for M60A3 tank units. This document outlines the unit training necessary to attain and sustain crew through platoon tactical gunnery proficiency. It starts with the soldiers' current knowledge of their tank's functional capabilities and techniques of gunnery acquired from NET or AIT/BAT, and ends with a demonstrated proficiency on both gunnery (I-XII) and tactical (A-I) tables.

Problem

Armor units are organized for the specific purpose of engaging the enemy in combat and defeating him. To be prepared to fight, to succeed in combat on the modern battlefield, units schedule their training time and resources around annual tank gunnery exercises and development of combined arms tactical proficiency. Attainment and sustainment of individual skills, aside from those embedded in scheduled training, are made the responsibility of each soldier and his immediate tank commander or platoon sergeant supervisor.

Such training, to include the cross-training of personnel to occupy new duty positions, is not formally scheduled, but expected to occur on-the-job and during periods of training opportunity, i.e., whenever time is available to conduct training.

The importance of sustainment training in the Army needs little emphasis. Skills not practiced tend to decay and knowledges unused are quickly forgotten. Thus, the benefits gained from training either through NET or AIT/BAT can be largely lost by the end of one year. In active Army units, personnel turbulence, doctrinal changes to accommodate advanced weapon systems deployment, added operational and maintenance requirements, and the increased demands for non-training related support compound efforts to sustain individual skills within the unit. This is additionally critical for Reserve Component and National Guard elements due to their limited initial NET. At home station, unit commanders must maximize training opportunities with the time and resources available and the training restrictions that are imposed on their unit.

Proposed Solution

With the requirement for sustaining individual skills as the focus, a joint TRADOC-ARI research and development effort was planned to provide armor units with training materials that individual soldiers could use to supplement, enrich, and thereby sustain recently acquired skills. This objective provided the basis for a two-phase research study that included a development phase and an evaluation phase.

In the development phase, (a) critical job performances were identified for which training materials would be developed, and (b) self-contained Study Guides were prepared to convey the knowledges and permit soldiers to use those knowledges in an applied setting.

The evaluation phase of the research study was designed to (a) determine the nature and training gains made possible by use of the Study Guides and (b) assess the utility and user acceptance of the materials in sustaining previously acquired skills and knowledges.

As stated earlier, the rationale for the development of sustainment training materials centered on the proposition that units have neither the time nor the resources to provide sustainment training. By providing self-contained study materials, it was hypothesized that:

a. Presentation of subject matter using a more structured and programmed approach, along with situational exercises for real world application, would help soldiers achieve a higher level of proficiency.

b. Soldiers who use the training materials would respond favorably and recommend their distribution to units.

METHOD

Selection of Training Content

Subject matter experts (SME) from the M1 Abrams NET team and Weapons Department, USAARMC, were interviewed to identify areas for sustainment training material development. The procedure used by the research team to gather SME data involved three general steps. First, each SME was provided a copy of the approved task list developed by the Directorate of Training and Doctrine (DOTD) for training MOS 19K10-40 M1 Armor crewmen. They were then asked to individually identify those tasks which required sustainment training materials by duty position and then to rank-order those tasks in terms of perceived training needs of unit personnel. The final step was to collectively discuss the tasks, their training priority, and arrive at a group consensus.

As experienced trainers and course developers in one or more areas of armor operations, the SMEs were able to identify three specific performance areas where such materials would be immediately beneficial to individual soldiers: fire commands, degraded gunnery, and multiple returns. These tasks are extremely complex and require that the tank commander and gunner possess extensive knowledge related to equipment operation and equipment capability. They must then, using this knowledge, rapidly make critical decisions. On the battlefield, the quality of those decisions directly impacts on target engagement outcomes--both in terms of target destruction and crew survival. For example, before issuing a fire command the tank commander must decide which target(s) is most dangerous and thus, engaged first; which weapon(s) should be used to defeat the threat; which type of ammunition should be fired, if the main gun is to be used; and if there are two or more targets present, whether they should be engaged simultaneously or sequentially. When multiple range returns are received from the laser rangefinder system, the tank commander and/or gunner must quickly determine whether the range displayed is correct, whether to select the first or last range return, whether to release to the target, whether to input a predetermined battlesight range; or whether to index an estimated range into the tank's ballistic computer. If before or during the engagement one or more system components fail or malfunction, the tank commander and/or gunner must quickly identify the malfunction, correct for it, and/or employ gunnery techniques which circumvent the problem. This is extremely complicated due to the number of systems involved and the range of possible actions that either the tank commander and/or gunner may take in response to various malfunctions. To highlight the enormity of degraded mode gunnery decisions, there are over eleven major systems components in the M1 Abrams tank which, when malfunctioning in combination with one another, present more than two thousand possibilities.

To determine whether these same performance areas were perceived similarly for M60A3 sustainment training development efforts, several M60A3 SMEs were interviewed individually over a two-week period. Not surprisingly, the results were the same with the acknowledgements that most soldiers (a) receive very little in the way of formalized training in these areas, and (b) that readily available materials for providing formal or refresher training simply were not available.

Personal review of the POIs approved for BNCOC, along with classroom visits to discuss related training matters with BNCOC staff, confirmed these SMEs views. From the BNCOC instructor perspective, how to issue fire commands is presented in several chapters of the Tank Combat Tables for M1 and M60A3 tanks, as are the basics of degraded mode gunnery and multiple returns. They feel that these skills and knowledges must be learned as tank crew-members gradually progress from driver-loader to gunner and tank commander. The Tank Combat Tables however, are not designed to teach these knowledges and skills. Self-contained study guides which could be used to provide such training were needed and would be of considerable benefit during BNCOC.

Development of Materials

The approach taken to develop the M60A3 sustainment training materials was modeled after the procedure for developing sustainment materials for the M1 Abrams units. First, knowledge booklets were developed to present the subject matter content required to issue fire commands, perform degraded mode gunnery operations, and respond to multiple returns. Scenario booklets were then developed which required soldiers to apply those basic knowledges in simulated combat situations. The next two tasks were to develop user instructions and training notes for the tank commander and incorporate them into the knowledge and scenario booklets. The procedures used in performing each of these specific efforts are described below.

Knowledge Booklets. A quick literature search was conducted to identify available resource material on fire commands, degraded mode gunnery, and multiple return strategies for the M60A3 tank. Of the three documents found available, only two were considered directly applicable; the operators manual (TM 9-2350-253-10) and the draft tank gunnery manual (FM 17-12-3). These resource documents were subsequently reviewed and the relevant subject matter content identified. Following initial outlines of the training content, instructional units were then written to cover the required knowledges and these units organized into sections within the booklets. After each section, several multiple choice questions were added to permit soldiers to assess their comprehension and mastery of the subject matter. Such feedback was considered essential for effective learning and a major component of the booklets. Answers to these questions were included at the end of the page and presented upside down to discourage copying behavior.

Scenario Booklets. Four major steps were involved in developing the scenarios. The first step was to storyboard armor combat situations which required soldiers to apply the knowledge presented in the booklets on issuing fire commands, degraded mode gunnery, and multiple return strategies. For each situation a list of constraints or conditions was identified for both the M60A3 tank and the threat. Included in this listing were such factors as: mode of operation, battlefield environment, equipment status, number and types of threat vehicles present in field of view, equipment malfunctions and target engagement results. Efforts throughout development proceeded from simple to more complex situations providing soldiers a crawl-walk-run learning strategy. The next step was to pictorially represent the combat situation using a number of line drawings. Vehicle shapes, distance cues, and tactical considerations were tailored to fit the situation and increase

realism. Where the situation could not be portrayed satisfactorily, the storyboard situations were revised. The third step taken was to develop questions that required the soldier to "solve" the situation. For the initial scenarios in each booklet, the soldier was asked to circle an answer from among multiple choice alternatives. In more advanced scenarios he was asked to construct a written response to fit the situation. Answers to both types of questions were provided along with a brief reiteration of the knowledge-based content. Remedial information was included to explain multiple choice alternatives that were incorrect. The fourth and final step was to package the various parts in a booklet format. Each scenario or snap-shot of the battlefield situation was displayed on the top half of an 8 1/2" by 11" page, centered and titled according to the number of scenarios developed. The bottom half of that page was divided in two sections. Under the title, THE SITUATION, a list of relevant conditions was presented with each one-liner preceded by a darkened circle or "bullet." The remaining section presented the question and, if applicable, the multiple choice alternatives. The following page was used to provide feedback and remedial type instruction with each allocated one-half page respectively.

User's Guide. This part of the materials development effort was designed to provide soldiers with the instructional guidance necessary to readily use the various knowledge and scenario booklets on their own. To encourage utilization the following format was designed: a statement of the overall training objective, a description of how the subject matter was organized within the booklet, the knowledges and skills required before using the materials, and a step-by-step procedure on how to use the booklet for self-instruction. After several revisions, this material was finalized and included in the front part of each booklet.

Tank Commander Training Notes. To complete the development phase of this research additional guidance material was developed for use by tank commanders. This material included a statement of the overall training objective, an organizational overview of the booklets contained within a subject matter area, the purpose of the booklets and its prerequisites, and a description of alternative ways of using the booklets to achieve other objectives. Initial drafts of the material were completed, revised, and included after the User's Guide section of each knowledge booklet.

EVALUATION STUDY

Evaluation Plan. The basic plan of the evaluation was centered on a comparison of Pretest and Posttest scores between two groups of soldiers: one that had been given the M60A3 Study Guides for use during a one month period (Experimental Group, EG), and one that had not received the materials during this same period (Control Group, CG).

Two replications of the evaluation plan were conducted. Each study spanned approximately five weeks. The first and last days were used in pretesting and posttesting personnel. The four weeks in between were to be used by study participants at their units, with the Experimental Group completing the Study guides on their own and in their free time.

Study Personnel. Two M60A3 tank companies from separate Active Army battalions provided troop support for the evaluation studies. The selection criteria used for both studies required the participants to be enlisted and with at least five months of military service left in their respective tank companies. Since both units were restructured under the Division 86 concept, the maximum number of participants totaled 180: 90 for each study, 45 each for both the experimental and control study groups. At the start of Study I only 58 soldiers were made available from the two companies. Aside from routine personnel shortages, most of the attrition was explained by soldiers waiting reassignment, on temporary duty, on leave, or pending medical action. By the end of the data collection only 51 soldiers were available for posttesting: 25 in the Experimental Group (EG), and 26 in the Control Group (CG). Similarly, only 19 soldiers were available for Study II, with 10 in the EG and four in the CG by the end of data collection. In addition to the above rationale for attrition, battalion priorities were redirected toward tank gunnery and mission-based FTXs for departure to the National Training Center (NTC).

Background characteristics of the participants in the two studies were quite similar. As shown in Table 1, Study I participants averaged 3.7 years of military service with about 38 months of armor experience; nearly 18 months of which was spent on M60A3 tanks. In comparing the participants by company (EG vs. CG), the CG averaged about one more year of military service than the EG. The CG also had about nine and one-half months more armor experience than the EG, but only one-half year more M60A3 tank experience. Study II participants averaged 3.5 years of military service. Their average armor experience was approximately 40 months with almost 14 months average experience on the M60A3 tank. Comparison of participants by company indicated that the EG averaged about three more years of military service and two more years of armor experience than the CG. The difference in M60A3 experience, however, averaged less than one-half month. In both studies with the exception of three E-2 and one E-7, most of the soldiers (72%) held the rank of E-4 or E-5.

Test Development. As mentioned, M60A3 knowledge and scenario booklets were developed for three subject matter areas: issuing fire commands, degraded mode gunnery, and multiple return strategies. The initial test item pool included both the multiple-choice questions contained in the original booklets and 120 additional multiple-choice test items drafted for the pre and posttest evaluation. These test questions, along with test directions and a biographical information sheet, were then submitted to research staff members for review and evaluation. Revisions following this effort resulted in a 63-item multiple choice test. Each item or question was based on information presented in a combat situation, and roughly equivalent in terms of subject matter coverage.

The preliminary test instrument was administered in its entirety on a trial basis to two E-7 M60A3 SMEs within DOTD. Results of this trial were used to further screen and revise the test instruments and validate test answers. Based on the SMEs evaluation, no additional test development trials were considered necessary.

Table 1

Selected Background Characteristics of
Study I and II Participants (In Percentages)

Characteristic	Study I			Study II		
	Control (N=26)	Experimental (N=25)	Total (N=51)	Control (N=4)	Experimental (N=10)	Total (N=14)
Years in Military	4.2	3.2	3.7 *	1.5	4.3	3.5
Military Rank						
Private (E-2)	-	1	1	1	1	2
Pvt 1st Class (E-3)	3	3	6	2	-	2
Corporal (E-4)	12	9	21	1	3	4
Sergeant (E-5)	7	11	18	-	4	4
Staff Sgt (E-6)	4	1	5	-	1	1
Sgt 1st Class (E-7)	-	-	-	-	1	1
Months in Armor	42.3	33.7	38.1	18.8	47.8	39.5
Months in M60A3	17.6	17.0	17.3	13.3	13.6	13.5

Questionnaire Development. An 18-item Training Utility Questionnaire was developed to assess soldier attitudes about the study booklets, and obtain feedback on the instructional materials. To assess attitudes, questions were directed toward: amount of material learned, perceived usefulness of the materials in sustaining one's own skills and the cross-training of other personnel, continued use of the materials to sustain performance, comparison with other training materials used, whether the materials should be distributed to units and/or used in institutional training, and changes that would increase the materials utility.

Feedback on the instructional materials was obtained by asking soldiers to report on: the booklets they used and time spent on each, whether they possessed the training prerequisites, use of training references while using the booklets, reading level of the materials, provisions for applying the information presented, and number of errors noticed in the booklets.

Procedure. The administrative and test procedures were the same for both Study I and Study II. The procedure used was as follows:

a. Battalion commanders were briefed on the project and arrangements coordinated with the battalion S-3 for troop support. Two group testing sessions, one for both the EG and CG, were arranged on consecutive days for both the pretest and posttest to accommodate personnel scheduling.

b. When the soldiers arrived for testing they were interviewed to determine whether they were eligible (enlisted with at least five months of military service remaining in their respective units) to participate in the

study. Those who did not qualify were dismissed, while the rest were administered the Pretest. Before testing began it was explained that the results would be used to support the development and implementation of crew sustainment training materials in M60A3-equipped units, and that their test results would be kept fully confidential. They were also informed that they would be directed to return in approximately four weeks for retesting. Soldiers were then instructed to read the Privacy Act Statement attached to the test and, if they agreed to participate, to continue to the next page, complete the biographical information, and read the test directions. After answering questions about the test procedures, testing began. At the end of the examination period soldiers in the Experimental Group were given the Study Guide materials and instructed in their use and return.

c. Approximately four weeks later soldiers were administered the posttest in the same manner as the pretest was given. In addition, all personnel in the Experimental Group were asked to complete the Training Utility Questionnaire that had been developed earlier. Also, the Study Guide booklets used by them were collected and replacement copies furnished to them for their personal use.

RESULTS

Study I

Pretest and posttest scores for the two groups are given in Table 2. The average percent of test questions passed is shown for each subject matter area as well as for the total score. Similarity of total scores on the pretest for the experiment and control groups (42.43% vs. 40.92%) is what would normally be expected when comparing companies selected from within the same battalion. Posttest total scores are likewise similar, with only a marginal gain in total test performance suggested for the EG. As shown, most of this difference results from improvement by EG soldiers in multiple returns (MR) subject area (19.08% to 30.15%).

The performance of soldiers in both study groups was compared by analysis of variance with repeated measures. No significant differences were found between the group overall, indicating that soldiers who received the study booklets performed no better or worse than those who did not receive the training materials.

As shown in Table 3, soldier performance on the Multiple Returns posttest was significantly greater than performance on the pretest as indicated by a significant test effect, $F(1,49) = 7.70$, $p < .01$. Post-hoc comparison using the Tukey HSD test² revealed that performance on the posttest was significantly greater than performance on the pretest for the Experimental Group ($p < .05$), but not significant for the Control Group. All other tests by subject area comparisons were nonsignificant.

²Kirk, Roger E. Experimental Design: Procedures for the Behavioral Sciences. Belmont, Calif.: Brooks/Cole Publishing Co., 1968.

Table 2
Pretest and Posttest Scores (Average Percent Correct)
for the Two Study Groups (Study I)

Subject Area ^a	Control Group (N=26)		Experimental Group (N=25)	
	Pretest	Posttest	Pretest	Posttest
FC	53.05	53.71	52.00	52.00
DG	39.27	37.85	38.95	39.58
MR	23.37	25.74	19.08	30.15
Total Test	42.43	42.8	40.92	43.48

^aSubject areas are: Fire Commands (FC), Degraded Gunnery (DG), and Multiple Returns (MR).

Table 3
Summary Table for the Analysis of Variance
with Repeated Measures of the Experimental Group (EG)
VS. the Control Group (CG) on Pre-Posttest Multiple Return Performance
(Study I)

SOURCE	SS	df	MS	F
Mean	1041.57	1	1041.57	-
Groups (EG vs. CG)	0.00	1	0.00	0.00
Error	255.08	49	5.21	-
Test (Pre vs. Post)	19.46	1	19.46	7.70*
Group x Test	8.17	1	8.17	3.23
Error	123.85	49	2.53	-

* $p < .01$

Table 4 from the Training Utility Questionnaire provides data to help explain the disappointing performance of the EG on the posttest. Nearly one-fourth (24%) of the soldiers in the EG reported not using the Study Guide booklets, with about two-thirds (65%) of those who did use the materials spending less than two hours per subject area.

Analysis of the 19 Study Guide booklets returned by soldiers in the EG provides supporting evidence. As shown in Table 5, only two soldiers completed both the knowledge and scenario booklets on fire commands (FC), none on degraded gunnery (DG), and four on multiple returns (MR). The fact that four soldiers in the EG completed the Multiple Return booklets is reflected in the significant test effect from pretest to posttest shown in Table 3.

Table 4

Number of Soldiers (EG) by Amount of Reported Time Spent Studying Booklets and Subject Area (Study I)

Subject Area ^a	N	Reported Study Time (Hours)				
		0	.5-2	2.5-6	6.5-13	13.5 or more
FC	25	6	14	3	2	-
DG	25	8	10	4	3	-
MR	25	7	11	4	2	1

^aSubject areas are: Fire Commands (FC), Degraded Gunnery (DG), and Multiple Returns (MR)

Presented in Appendix A are the results of the Training Utility Questionnaire. Since the validity of data is questionable, because of so few soldiers completing both booklets as shown in Table 5, caution must be exercised in interpreting the following summary.

Soldiers who used the study booklets reported spending an average of less than two hours in each subject area (Table 4). Almost everyone (90%) reported having the necessary prerequisite skills to use the training materials, that there was no need to refer to either FM 17-12-3 or the M60A3 Operators Manual while using the training materials, and that the overall reading level of the materials was about right. All reported learning something (63% "a lot") from using the materials, having ample practice opportunities, and finding very few errors. Ninety-five percent found the booklets either "very" or "moderately useful" for individual skills sustainment and for cross-training other personnel. In comparison to other materials they have

used. 32% of the soldiers reported these materials to be "average" while 58% rated them "above average", and 10% "best of all". Nearly 80% indicated they would continue to use the booklets, mostly to sustain and refresh their skills. The vast majority (89%) favored distribution of the materials to units, primarily to every tank commander and gunner. They also favored using the materials during institutional training (93%), especially in the Basic Noncommissioned Officer Course (BNCOC). The two changes most often recommended were to place the answers to knowledge questions at the end of the booklets, and to combine the knowledge and scenario booklets into one.

Table 5

Number of Soldiers (EG) by Number of Study Booklets Completed and Subject Area (Study I)

Subject Area ^a	N	Study Booklets Completed		
		Knowledge	Scenario	Both
FC	19	7	5	2
DG	19	2	2	-
MR	19	5	4	4

^aSubject areas are: Fire Commands (FC), Degraded Gunnery (DG), and Multiple Returns (MR)

Study II

Table 6 shows the pretest and posttest scores for the two study groups. In general, the average percent of questions passed on the pretest by the Control Group (35.66%) is less than that of the Experimental Group (48.68%). This thirteen percent difference in group performance is attributed primarily to the limited size of the Control Group ($n=4$ vs $n=10$) rather than reliable differences in soldier proficiency. Closer examination of the data will show that the Control Group actually had a higher overall gain in total performance (7.3% vs 5.9%), with most of this gain due to better performance in the Degraded Gunnery (DG) study area. Because of the small number of subjects in the Control Group, however, no further statistical analysis of the data was conducted.

Table 7 from the Training Utility Questionnaire provides data reported by soldiers in the EG who received the training materials. Half reported not using any of the Study Guides. Of the five soldiers who reported using the guides only one reported spending more than one-half to two hours on each set.

Table 6
Pretest and Posttest Scores (Average Percent Correct)
for the Two Study Groups (Study II)

Subject Area ^a	Control Group (N=4)		Experimental Group (N=10)	
	Pretest	Posttest	Pretest	Posttest
FC	48.27	52.58	53.10	58.62
DG	23.68	42.10	50.52	55.26
MR	25.00	23.07	36.15	44.61
Total Test	35.66	43.03	48.68	54.59

^aSubject areas are: Fire Commands (FC), Degraded Gunnery (DG), and Multiple Returns (MR).

Table 7
Number of Soldiers (EG) by Amount of Reported
Time Spent Studying Booklets and Subject Area (Study II)

Subject Area ^a	N	Reported Study Time (Hours)				
		0	.5-2	2.5-6	6.5-13	13.5 or more
FC	10	5	4	1	-	-
DG	10	5	4	1	-	-
MR	10	6	3	1	-	-

^aSubject areas are: Fire Commands (FC), Degraded Gunnery (DG), and Multiple Returns (MR).

Analysis of booklets returned by soldiers in the EG provides the data shown in Table 8. As indicated, less than one-third of those who reported using the study booklets actually completed them. In fact, one soldier who reported spending six hours of study time on each set of booklets completed just the knowledge booklet for one subject area.

Table 8

Number of Soldiers (EG) by Number of Study Booklets
Completed and Subject Area (Study II)

Subject Area ^a	N	Study Booklets Completed		
		Knowledge	Scenario	Both
FC	10	3	1	1
DG	10	2	1	1
MR	10	4	2	2

^aSubject areas are: Fire Command (FC), Degraded Gunnery (DG),
and Multiple Returns (MR).

The results of the Training Utility Questionnaire are presented in Appendix B. As in Study I, these data are of questionable validity because so few subjects completed the booklets and should be considered as such when interpreting the following summary.

Soldiers who used the study booklets ($n=5$) reported spending an average of about one hour in each subject area (Table 7). All indicated having the prerequisite skills to use the training materials. Only one soldier reported using additional referenced material during his study. All reported the reading level to be "about right". Most (80%) indicated they learned "a little" (80%) and received sufficient practice opportunities to apply the information learned (80%). They also considered the booklets "moderately useful" for sustaining their own skills (60%) and for cross-training other personnel (80%). Despite a few errors, most soldiers found the booklets comparable to other training materials (75%), and all recommended their distribution to units (every tank commander and gunner) and for use in institutional training. Most (80%) preferred making the booklets smaller by combining the individual booklets within a subject area.

DISCUSSION AND CONCLUSION

The purpose of the research effort was twofold: to develop sustainment training materials for use by M60A3 equipped unit personnel, and to determine the training effectiveness of the materials by field evaluation. From a training material development viewpoint, the research was largely successful. Self-contained study booklets were developed for training in three subject areas termed critical by military SMEs: fire commands, degraded mode gunnery, and multiple returns. The training methodology combined the qualities of incremental learning, self-paced instructional techniques, and the use of immediate feedback through knowledge of results for knowledge acquisition. Realistic job-like problem situations were constructed using both written

and pictorial representations that permitted practical application of the acquired knowledge for skill development. For both knowledge acquisition and skill development, the intent was to stimulate additional learning processes which would presumably lead to heightened retention and to more highly probable transfer of skills to novel instances and situations. Also, as soldiers completed the scenarios the cognitive processing of the information presented in the knowledge booklets would become more automatic rather than controlled.

Military personnel who received the training materials have provided very positive feedback to support their use for individual skills sustainment as well as for cross-training purposes. This perceived training utility and acceptance of the materials, despite the apparent lack of use during the study evaluations, is noteworthy, for without such perceptions even the most effective training materials would be doomed to failure.

From an evaluation perspective, the research effort was disappointing. Most soldiers who received the training material failed to use them during the four week studies. Several underlying factors likely contributed to this failure. In Study I, most soldiers were involved in supporting other military research efforts, especially those being conducted by the US Army Armor and Engineer Board at Fort Knox. This requirement to support two or more organizations during the same time period is not uncommon. Unfortunately, soldiers participating in this research effort were asked to study training materials on their own time and whenever training opportunities arose during their daily schedules. Since it is quite likely that training opportunities were available, the only plausible reason for not using the materials is an unfavorable attitude towards self-study. Support for this argument is available in the literature, but can be easily confirmed by a quick visit to any military unit's learning centers. Most, if not all available self-contained materials, primarily Training Extension Course (TEC) tapes, are unused. Whether the cause for such non-use is low motivation or insufficient time available to study lies beyond the scope of this report.

In the second study, a more obvious reason for soldier non-participation was discerned. The unit itself was redirected to begin preparations for deployment to the National Training Center (NTC). With very limited preparation time available, military support personnel were required to work doubly hard just to keep pace with the situation. With such a change in unit priorities occurring during the first two weeks of the study, little could be done to prevent what happened short of terminating the study.

In the final analyses it cannot be overemphasized that tank crews need these kinds of training materials to enrich and sustain their individual pre-test and post-test skills. The results clearly show that less than 50% of the pre-test and post-test questions were answered correctly by the 65 soldiers participating in the studies. They simply have not mastered the knowledges required to issue fire commands, respond to degraded modes of tank gunnery operation, and deal with multiple range returns; a minimum necessity for success in combat. An effective means of improving the quality of training and initiative of soldiers to obtain exemplary mastery of combat materials and weapons must be imposed and implemented at all levels. Given their highly positive acceptance by both officer and enlisted personnel alike, these materials are a significant step in that direction.

Conclusions and Implications

Results of this research effort, including observations reported by soldiers completing the Training Utility questionnaire, led to the following conclusions.

a. For most soldiers, the training materials were perceived favorably for both sustainment and cross-training purposes.

b. For both study groups that used the training materials, neither benefitted over those that did not receive them. Overall, soldiers in both studies knew less than 50% of the total subject matter.

c. Most soldiers who received the training materials did not use them as intended either because of higher unit priorities, low motivation, and/or lack of available study time.

Implications that should be given further consideration are:

a. Evaluate the use of the training materials in a classroom setting controlling for the amount of materials self-studied at any one time.

b. Issue every tank commander and gunner in an M60A3 unit a copy of the training materials and ensure their use through command emphasis and quality control measures.

c. Incorporate the training materials into the Basic Noncommissioned Officer course for M60A3 tank commanders, training the trainers how to use the materials in conjunction with Soldiers Manual.

d. Provide a motivation/incentive system to accompany such materials to the field.

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APPENDIX A
SUMMARY OF TRAINING UTILITY QUESTIONNAIRE DATA: STUDY I

TRAINING UTILITY QUESTIONNAIRE

1. In what duty position are you currently assigned? (Check one.)

TC 10 Gunner 6 Other 9

2. Did you use each set of booklets? (n=24)

Fire commands	Yes <u>19</u>	No <u>5</u>
Degraded gunnery	Yes <u>17</u>	No <u>7</u>
Multiple returns	Yes <u>17</u>	No <u>7</u>

If you didn't use any of the booklets, don't complete the rest of this questionnaire.

3. How many hours (to the nearest half-hour) did you spend using each set of booklets? (n=25)

	Average
Fire commands	<u>1:45</u> hrs
Degraded gunnery	<u>1:53</u> hrs
Multiple returns	<u>2:02</u> hrs

4. Did you have the background knowledge and skills necessary for using the booklets? Yes 19 No 2 (n=21)

If no, what training did you need to prepare for using the booklets?

- o Not A3 qualified
- o Unspecified

5. Did you refer to FM 17-12-3 while using the booklets? Yes 2 No 19 (n=21)

If yes, for what purpose?

- o For comparing technical information.

6. Did you refer to the M60A3 Operators Manual (TM 9-2350-23-10, w/ch 1 and 2) while using the booklets? Yes 1 No 20 (n=21)

If yes, for what purpose?

- o For assistance in conducting LRF and Computer Self-Test.

7. How would you describe the reading level of the booklets? (n=19)

Too Easy 1 About Right 18 Too Hard 0

8. How much did you learn from using the booklets?

A lot 12 A little 7 Nothing 0

9. Do the booklets provide enough practice in applying the information they present? Yes 16 No 3 (n=19)

If no, what additional practice is needed?

- o More scenarios with better descriptions of battlefield
- o Reusable materials (flashcards)

10. How useful are the booklets for sustaining your own skills? (n=19)

Very useful 9 Moderately useful 9 Not useful 1

11. How useful are the booklets for cross-training other personnel? (n=18)

Very useful 12 Moderately useful 5 Not useful 1

12. Did you notice any errors in the booklets? Yes 5 No 13 (n=18)

If yes, estimate how many and give an example. _____

- o Question #20
- o Question on sustained rate of fire for LRF
- o Vehicle ID and target range in scenarios

13. How do these booklets compare to other training materials you have used?

Best of all 2 Above average 11 Average 6

Below average 0 Worst of all 0

14. Will you continue to use these booklets? Yes 15 No 4 (n=19)

If yes, how?

- o Sustainment training (n=7)
- o Refresher training (n=3)
- o Training platoon members (n=1)
- o Learning about M60A3 tanks (n=1)

15. Should these booklets be distributed to units? Yes 16 No 2 (n=18)

If yes, how?

- 4 Put in learning center or other central location
- 4 Give to every tank commander
- 10 Give to every tank commander and gunner
- 7 Other (explain) Issue to every tank crew member (n=5); Issue in armor AIT (n=2)

16. Should these booklets be used in institutional training? Yes 14 No 1
(n=15)

If yes, where?

<u>5</u>	PNCOC
<u>9</u>	BNCOC
<u>6</u>	AOB
<u>4</u>	Other (explain) <u>US Military Academy (1); every armor crewman (1);</u> <u>AIT (1); AOB (1).</u>

17. What would you change, if anything, to make the booklets more useful?

Move answers to end of knowledge booklets (4); combine booklets in each
subject area (3).

18. Provide any other comments you have about these booklets.

- o "They would be very useful to keep for further references."
- o "Very good!"
- o "Not enough time to study."
- o "Before reading I was not sure how to give fire commands or determine the most dangerous threat. Now I am."
- o "Books should be used before tank gunnery training and during AOB, AIT."
- o "I believe if they combined all of the booklets into one that for first they would last longer and second the people utilizing them would be more likely to keep it with them."
- o "These booklets had tons of information that I didn't know. I'd never been to A3 transition training and these booklets filled a lot of gaps in my knowledge. If I would have spent more time reading the booklets I'm sure I wouldn't have missed any on the test."
- o "Overall these booklets are very informative and useful. I feel that they are far more useful than the soldiers manual when it comes to gunnery skills. That's why I think every 19E should get a set."

APPENDIX B
SUMMARY OF TRAINING UTILITY QUESTIONNAIRE DATA: STUDY II

TRAINING UTILITY QUESTIONNAIRE

1. In what duty position are you currently assigned? (Check one.)

TC 4 Gunner 5 Other 1

2. Did you use each set of booklets?

Fire commands	Yes <u>5</u>	No <u>5</u>
Degraded gunnery	Yes <u>5</u>	No <u>5</u>
Multiple returns	Yes <u>4</u>	No <u>6</u>

If you didn't use any of the booklets, don't complete the rest of this questionnaire.

3. How many hours (to the nearest half-hour) did you spend using each set of booklets? (n=5)

	<u>Average</u>
Fire commands	<u>1:10</u> hrs (<u>n</u> =5)
Degraded gunnery	<u>1:10</u> hrs (<u>n</u> =5)
Multiple returns	<u>1:00</u> hrs (<u>n</u> =4)

4. Did you have the background knowledge and skills necessary for using the booklets? Yes 5 No 0 (n=5)

If no, what training did you need to prepare for using the booklets?

N/A

5. Did you refer to FM 17-12-3 while using the booklets? Yes 0 No 5 (n=5)

If yes, for what purpose?

N/A

6. Did you refer to the M60A3 Operators Manual (TM 9-2350-23-10, w/ch 1 and 2) while using the booklets? Yes 1 No 4 (n=5)

If yes, for what purpose?

Not specified

7. How would you describe the reading level of the booklets? (n=5)

Too Easy 0 About Right 5 Too Hard 0

8. How much did you learn from using the booklets? (n=5)

A lot 1 A little 4 Nothing 0

9. Do the booklets provide enough practice in applying the information they present? Yes 4 No 1 (n=5)

If no, what additional practice is needed?

Not specified.

10. How useful are the booklets for sustaining your own skills?

Very useful 2 Moderately useful 3 Not useful

11. How useful are the booklets for cross-training other personnel?

Very useful 1 Moderately useful 4 Not useful

12. Did you notice any errors in the booklets? Yes 4 No 1

If yes, estimate how many and give an example.

- o A few (n=2)
- o Answer to p. 33 in Degraded Mode booklet should be B or C. (n=1)
- o Use Cal .50 against helicopter. (n=1)

13. How do these booklets compare to other training materials you have used? (n=4)

Best of all 0 Above average 1 Average 2

Below average 1 Worst of all 0

14. Will you continue to use these booklets? Yes 2 No 3 (n=5)

If yes, how?

- o To train lower ranking EM -- give them practice.
- o Going through and analyzing each situation until I know the right answers every time.

15. Should these booklets be distributed to units? Yes 4 No (n=4)

If yes, how?

- 3 Put in learning center or other central location
- 1 Give to every tank commander
- 3 Give to every tank commander and gunner
- 2 Other (explain) Provide to each crewmember. Provide one per tank after errors are corrected.

16. Should these booklets be used in institutional training? Yes 3 No 0
(n=3)

If yes, where?

1 PNCOC

1 BNCOC

2 AOB

0 Other (explain) _____

17. What would you change, if anything, to make the booklets more useful?

Make booklets smaller. Remove answers. Make certain errors are

eliminated by debugging with some tankers.

18. Provide any other comments you have about these booklets.

- o "Each crew member should actually have access to the knowledge (we are combat troops and people die under circumstances and other crew members may find that they need to know what's going on (what to do) if such an emergency comes up."
- o "I actually did not spend very much time using the material, but when I did I found that the booklets (ask) very good questions about my job that I should know 100%. These booklets are very good material for learning these tasks."
- o "Authors of booklets should know more about M-60A3."
- o "I think personally that the books are good material and hope I have more time with them to go over."
- o "Just the mistakes, all of them on the questions and answers. The hard knowledge parts are O.K."